PAPER • **OPEN ACCESS**

Operation of high-technology product development based on functions and value

To cite this article: M A Prilytskaya *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **709** 033049

IOP Conf. Series: Materials Science and Engineering **709** (2020) 033049 doi:10.1088/1757-899X/709/3/033049

Operation of high-technology product development based on functions and value

M A Prilytskaya, A D Murukina and O O Podoliak*

Institute of New Materials and Technologies, Ural Federal University named after the first President of Russia B.N. Yeltsin, 620002, 19 Mira street, Ekaterinburg, Russia

*o.o.podoliak@urfu.ru

Abstract. The sector of military-industrial enterprises was the most state supported in recent years. It is obvious that success of strategic initiatives is defined by efficiency of the enterprises diversification and can provide bringing domestic products to the world market with the highest level of competitiveness. Military-industrial enterprises (as drivers of the economy development) have to provide the implementation of several national programs and projects: industry development, diversification, import substitution of hi-technology products, production of the export-oriented products, increase of labor productivity, digital economy. That's why it is important to find effective solutions, which can provide achievement of several tasks. At the same time, effective development of civilian products is interfered by a number of organizational and economic conditions. For definition of the unique set of functionality and characteristics of a product on the basis of the unique customer needs (for competitive hi-tech export-oriented civilian products), the FSA was created. This model allows to provide the civilian products manufacture development due to paramount and constant orientation to requirements of the market and clients, and the production process improvements for cost reduction without damage to its quality.

1. Introduction

The military industry was one of the leading sectors in the Russian economy in recent years, and provided production and export increase based on production modernization and investments to research and development [1]. In 2016 the Russian President set the challenge to increase the percentage of the hi-tech civilian products and dual purpose in the general output of the military-industrial enterprises. The percentage of such products has to be 50% by 2030. Diversification projects implementation is considered as an ingredient in improving organizational effectiveness [2,3,4].

The features of the military industry are that most the enterprises were created only for military tasks; the main challenge in production is product tactical and technical characteristics; the delivered products and services are very specific; often the state is the single customer. The quasi-market relations, state price control on products ("expenses +") the cooperation chain, a long production cycle are characteristic of the military industry.

The researches conducted by military economy laboratory of Gaidar institute show that the military industry production average multiplier is 2.11, at the same time the relation "a direct and indirect contribution of military industry in productions / military expenses" makes about 70%, i.e. investments in military encumbrance exceeds return in the form of the received products [5].

Therefore, the condition that further financing increasing and support of the civilian production did not lead to competition between military industry and civilian manufacturing becomes the major. On the contrary, the military industry production multiplier has to grow due to effective expanded cooperation, including small and medium business.

2. The diversification problems in civilian products manufacturing

The research of indicators and the perspectives of civilian products production by military enterprises was conducted in 2017-2018 in the Ural Federal District. Within this research 27 of large military enterprises presented self-inspection forms, a number of working meetings and roundtables were held.

The received results allow to draw the following conclusions:

- the main part of the enterprises has a percentage of civilian products not higher than 10%. At the same time the share significantly will not grow by 2022 though in calculations essential growth rates of civilian products manufacturing is put. About 15% of the enterprises have 0% of the civilian products and do not predict its development because of the large state military order. These enterprises have no free production capacity for civilian products;
- the civilian production development is difficult because of existing products regular modernization lack and new products patent protection. In fact, this reflects the weak scientific and technical support of the diversification process and insufficient (ineffective) work with consumer inquiries. At the same time most the enterprises have a serious competition from foreign producers;
- an insignificant part of products has the export potential. But it is remarkable that those few enterprises which work mainly for export (having mastered breakthrough technologies), cannot sell the products in domestic market as the consumers are not ready to its use.
- most of the enterprises have the civilian production organization form mixed (in whole or in part) with state military order (Fig. 1).

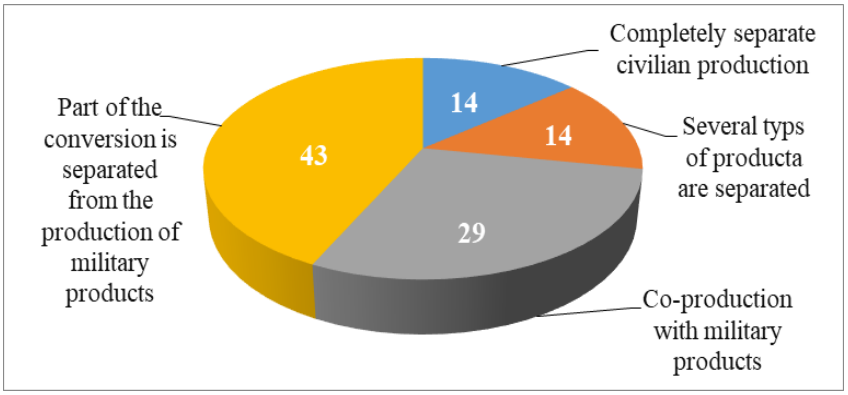

Figure. 1. Production separation from the state military order

Often, only the assembly (nodal or final) process is allocated (separated). Some enterprises provide the allocated civilian production, but these are those enterprises which have a high share of the civilian production in the output. It leads to the separate costs accounting problems, including setting the labor standards and allocation of overheads. High level of internal costs leads to ineffectiveness of the civilian production and requires the expanded cooperation.

On the basis of the conducted research, studying of the publications concerning diversification [3,4,6,7], materials of military-industrial conferences, military enterprises heads' meetings and meetings about the production diversification a number of important issues in civilian production development was identified(Fig. 2).

The success of scientific and technological progress results implementation into production is depends by diversification processes efficiency. It can be mentioned that the main problem is not the ideas and innovations deficiency or financial difficulties, it is a number of organizational and

economic barriers. Owing to these restrictions the enterprises are not ready to the innovations perception.

1. Marketing. One of the main diversification problems for the enterprises is the definition of a perspective civilian products. Now corporations undertook functions of integrators and begin to distribute spheres between the enterprises. It will take a lot of time, and it is necessary to take into consideration that priority interests are the corporate interests. In our opinion, the director has to be responsible for marketing strategy. Only the head is able to make a decision what to produce because the answer assumes not just the kind of a product, and responsibility for ensuring the necessary consumer properties within target prime cost. The state as the owner, and in some cases - the consumer, can offer various forms of the supporting, for example information, scientific, methodical support (in carrying out value analysis, reverse engineering). It can be realized through the scientific and technical cooperation.

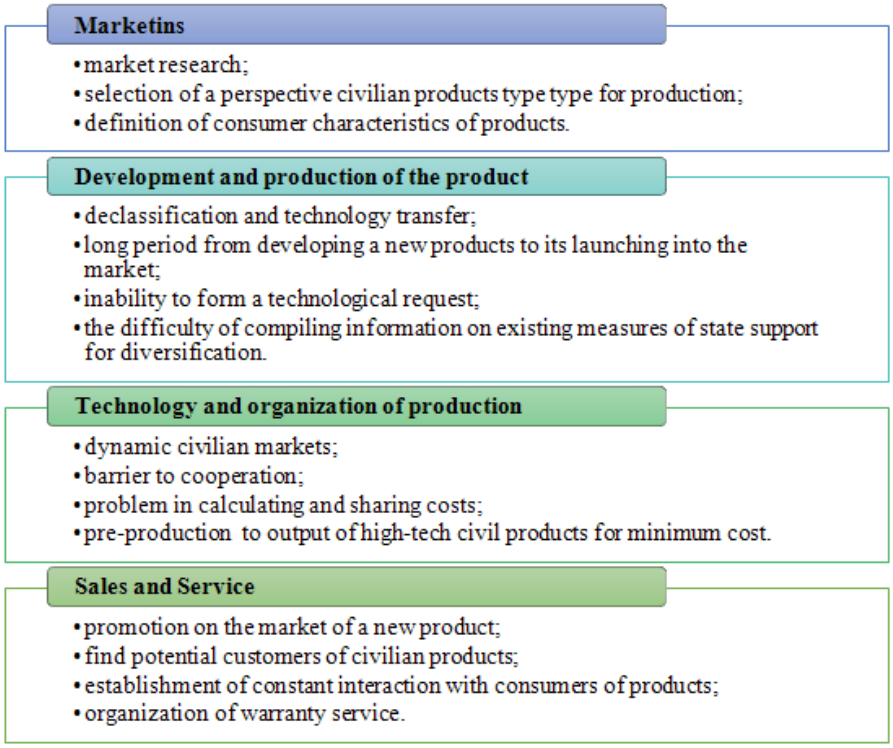

Figure. 2. The problems of the civilian products production development

2. Putting a product into manufacturing. For most of the mechanical engineering enterprises the normal term of development and putting a product into manufacturing is about 3 years. It means that we bring a yesterday's product to the tomorrow's markets. It is necessary to change the products development process. It is necessary to include in it the future consumers and provide the results verification on each step: from the technical specification formation and finishing with the finished product testing. Projects of financing of a new products development have to provide the expanded list of participants, especially when it concerns the quasi-state markets.
3. Technology and organization of production. This problem contains many questions connected with the equipment and technology and also with the lodor and production organization. It is necessary to provide not only flexibility of non-core products production, but also to reach competitiveness on its quality and the price.
4. Sales and service. The main problem is the lack of the adjusted feedback from clients and claims working off mechanisms. At the same time, it should be noted that sometimes the cost a domestic product life cycle is lower than foreign competitors can allow, with higher starting cost.

The proposed solutions of the civilian products manufacturing development problems:

- the choice of the civilian products manufacturing development direction (search of a new product niches taking into consideration the technological competences; completion of the existing products using the function and value analysis and TRIZ (theory of inventive problem solving); improvements in the field of rationing and expenses accounting; niches search for accessories production localization and others);
- formation of an effective cooperation chain throughout the product life cycle (from development till utilization);
- removal of economic and administrative restrictions;
- training implementation (retraining of existing employees, project training in education);
- application of marketing as a strategy.

Diversifiable enterprises will face the competitive environment that will demand from them development of absolutely new competences. Competitors quickly adopt decisions and develop the new ideas. Therefore, innovative activity at the enterprise has to represent continuous and systematic process.

3. Management of a high-technology product development

Using the TRIZ method "System operator" problem areas were found. Solution of this problems is necessary for effective diversification (Table 1).

Table 1. System operator

	past	**present**	**future**
Oversystem	Planning on the basis of extrapolation	strategic planning	strategic marketing
System	The decision on civilian products manufacturing was made on the basis of technological similarity to military products. Market research were not conducted	Development of functional strategy in marketing	?
Subsystem	«try out and mistake method»	Complex studying of all market; assessment of demand and requirements; development of marketing strategy and development of the methods allowing to realize it	?

As a "system" the way of products type definition is considered. Current system state can be characterized as using of the functional marketing strategy. It defines the goods, services and the markets to which the product can be offered, the most effective structure of a marketing complex (researches of the market, product and price policy, distribution channels and sales promotion).

Oversystem represents larger system which part is the considered system.

The past of the "oversystem" define the condition of a system on the basis of the organization activity indicators in the past by extrapolation. This way proceeds from full definiteness and predictability of the enterprise future development. The present of "oversystem" consists in management on the basis of changes anticipation (strategic planning). If there will be market conditions it will require the maximum flexibility from military enterprises. Strategic management can be the future of "oversystem". It means that the organization management have to focus on inquiries of consumers, flexibly reacting and carrying out changes timely.

Application of the "system operator" method allowed to define that for the hi-tech civilian products share increasing it is not enough to use only marketing tools. This tools can not allow the enterprises quickly create the "analogue +" product. The combination of the functional and value analysis and functional marketing strategy has to be a "system". "FSA Model" using can provide the understanding what market requirements are existed and how it is possible to satisfy them.

"Subsystem" is a part of a system or elements of the system.

Each idea, which materializes in an innovative product always demands costs on production and operation, has to be cost-effective. Overcoming contradictions between technical and economic requirements is promoted by the functional and value analysis (FSA). [8,9] Valuation (value) analysis is worldwide known approach (VA) [10,11,12]. But for both approaches the functional principle are taken as a basis. This principle has two closely connected parts. The first is marketing and provides that the consumer is interested in functions more than in a product itself. Therefore, in a new product it is necessary to put only those functions which are interesting for the consumer. Also the quality level has to be acceptable for the customer. The second part of the principle assumes elimination from a product of all excess functions which increase costs of its development, production, sale and operation [13,14,15].

Each product is made for satisfaction of certain requirements (implementation of functions). FSA is an effective way of cost saving reserves identification which is based on searching the cheaper ways of main functions implementation (by organizational, technical, technological and other production changes) at a simultaneous exception of excess functions. FSA is effective tool of the production efficiency increasing, strengthening of products competitiveness and resource-saving.

The developed FSA model (Fig. 3) will allow to make the decision on development and the production of a new products based on carrying out the market researches allowing to compare a new product consumer cost level to competitors' products and to draw conclusions on the level of the competitiveness.

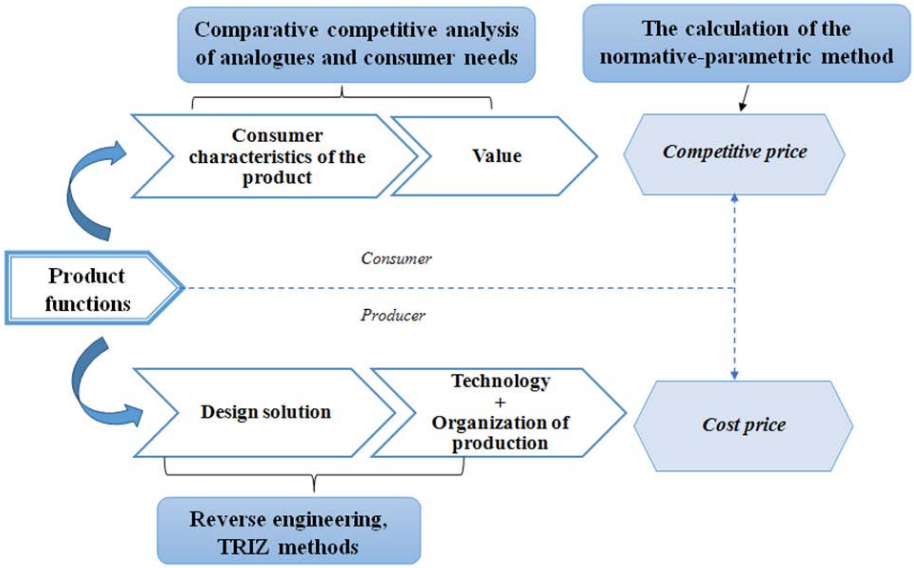

Figure. 3. Model of the functional and value analysis (FSA)

According to this approach each product is considered as the set of functions which it has to possess then it is required to mark out those functional characteristics and properties of a product to which consumers give the greatest preference.

Functions are understood as consumer properties (qualities) of an object which are subdivided on [16]:

1. the basic function expressing purpose of an object;
2. the main functions providing performance of the basic;
3. the support functions realizing the main;
4. excessive or unnecessary functions;
5. harmful functions

Certain functions need to be considered from the point of view of the consumer and the producer. Carrying out the market researches will allow to obtain necessary information on a state and trends of the market, information about users, intermediaries and producers.

Consumer characteristics of a product and its value (for the consumer), can be defined by the method of the comparative competitive analysis of analogs and inquiries of consumers. The revealed consumer characteristics and value will be a basis for the competitive price determination for a new product (expected market price) which calculation can be made by a parametrical method.

On the other hand, for ensuring production of a product with certain functions it is necessary to establish 3 aspects: what design decisions will allow to realize them; what technology will be required; how a new product production has to be organized with the cost minimization. The received decisions will allow to determine a new product cost. The effective combination a reverse engineering, the TRIZ methods, 3D - design and using of digital doubles will allow to create not to an analog of the existing product, but to the "analog+" with full understanding as for whom the enterprise offer this product, taking into consideration all economic restrictions.

Simultaneous assessment of a new product from the producer point of view (costs of design, production preparation and production itself) and the consumer (the required characteristics, the price level, value of this product) will allow the enterprises to use such method of product cost management as a method of target calculation (target costing). The main idea of which is to decrease the product cost during all its production cycle, due to application of production, engineering, research and development innovations. During target calculation planning in three strategic directions of competition is made: cost/price, quality, functionality [17,18].

During the military enterprises diversification, it is expedient to estimate what elements of an innovative product (knots, details) can be used by production of civilian products. Using the methods of the functional and value analysis will allow to estimate an opportunity and expediency of certain knots and elements continuity. This approach will allow to organize the general production of details and knots for military and civilian products. This option will allow existing of the parallel performance of business processes and accelerate creating of a new hi-technology types of products.

4. Conclusion

Thus, the created "FSA model" will allow to provide development of the import-substituting and export-oriented hi-technology civilian products manufacturing due to paramount and constant orientation to the market and clients requirements, production improvements for the cost reduction without damage to its quality, detection of the most significant consumer characteristics of a product determining the value of the final product and also competitiveness of products by the price.

References

[1] Shirov A, Gusev M and Frolov I 2018 Macroeconomic Effects of Russian Defense Expenditures: A Retrospective Analysis and Forecast *Studies on Russian Economic Development* **4** 343-351
[2] Meeting with the leadership of the Ministry of Defense and defense enterprises URL: http://www.kremlin.ru/events/president/news/59171
[3] Dubrovsky V and Ponomareva A 2018 Objectives of the production diversification strategy of defense enterprises *Human Progress* **5** URL: http://progress-human.com/images/2018/Tom4_5/Dubrovskiy.pdf
[4] Turovets O and Khromykh N 2017 Organization of the transition of the enterprises of the military-industrial complex to the production of high-tech dual-use and civilian goods (diversification) *ECONOMINFO* **4** 14-16

[5] Official website of the Institute of Economic Policy named after Ye.T. Gaidar URL: https://www.iep.ru/ru/
[6] Dubrovsky V and Ivanova Ye 2018 Changes in the product portfolio of defence contractors: global experience and opportunities for Russia *News of the Ural State Economic University* **2** 75-87
[7] Berkutova T 2018 Indicators of the effectiveness of the diversification of enterprises of the military-industrial complex *Vestnik IZhGTU im. M.T. Kalashnikov* **3** 136-141
[8] Gukova E and Ilyicheva E 2016 Functional-cost analysis: concept, principles, tasks and main stages S*cientific discussion: questions of economics and management* **54** pp12-15
[9] Garifulina P, Avdonkina E and Orsich E 2016 Functional-cost analysis as a means of business improvement *Innovation science* **13** 10-11
[10] Pires A and Avila P 2015 An approach about the value analysis methodology *Proceedings of 2100 Projects Association Join Conferences* **3** 16-21
[11] Marjan Leber et al. 2014 Value Analysis as an Integral Part of New Product Development 24th DAAAM International Symposium on Intelligent Manufacturing and Automation **69** (Vienna: Elsevier Ltd.) 90 – 98
[12] Jafarzadeh-Ghoushch S, Dorosti S and Asgari-Tehrani S 2017 Characteristics of the research on value engineering *World Review of Science Technology and Sustainable Development* **13(2)** DOI: 10.1504/WRSTSD.2017.084171
[13] Podhalyuzina V 2016 Functional-cost analysis and its differences from traditional methods of analysis *Baltic Economic Journal* **19** 56-62
[14] Pritula N 2016 Functional-cost analysis in the design of competitive export products *economy: realities of time* **23** 36-42
[15] Kulaga A 2017 Functional-cost analysis as a tool to improve the competitiveness of products and reduce its cost price *Scientific Journal* **19** 82-83
[16] Shatunova G, Arkhipova N and Kuzmina O 2013 Improving the methods of functional cost analysis in the current economic conditions *Economic analysis: theory and practice* **29** 13-20
[17] Yakupov I 2012 *Materials of the 2td Int. Scientific Conf. Problems of the Modern Economy* (*Chelyabinsk: Two members of the Komsomol)* 131-134
[18] Shigaev A 2004 Target calculation of the cost of production (method Target Costing) *Modern Accounting* **3** 14-20